REMARKS

The remainder of this Amendment is set forth under appropriate subheadings for the convenience of the Examiner.

Information Disclosure Statement

A Supplemental Information Disclosure Statement (SIDS) is being filed concurrently herewith. Entry of the SIDS is respectfully requested.

Amendments to the Claims

Claim 15 has been amended to correct a self-evident error. No new matter has been added.

Objection to Claim 15

Claim 15 has been objected to, because the terms "silicon nitride" and "silicon oxide" are misspelled as "silicone nitride" and "silicone oxide," respectively.

Applicant has amended Claim 15 to correct the misspelling. Withdrawal of this objection is respectfully requested.

Rejection of Claims 1-15 under 35 U.S.C. § 102(b)

Claims 1-15 have been rejected under 35 U.S.C. § 102(b) as being anticipated by U.S. Patent No. 6,001,669 to Gaines, et al. (hereinafter "Gaines, *et al.*")

The Examiner stated that Gaines, *et al.* disclose a method of forming an epitaxial film on a substrate, as claimed in Claim 1 of the instant application. On the contrary, Gaines, *et al.* do not disclose or suggest Applicant's invention of Claim 1 for the reasons set forth below.

Applicant's invention of Claims 1-15 is directed to a method of forming an epitaxial film on a substrate. The method includes the steps of growing an initial layer of a film on a substrate at a temperature T_{growth}, and annealing the initial layer of the film at a temperature T_{anneal}, thereby substantially completely relaxing the initial layer.

Gaines, *et al.* disclose a method that employs a migration enhanced epitaxy (MEE), involving alternate deposition of layers of the cation and anion species of semiconductor compound to be formed. For example, for a film of ZnSe, initial fractional monolayer 94 of either Zn or Se ("initial deposition") was deposited on lattice-matching substrate 92 at either 200 °C or 500 °C ("$T_{initial}$") for separate individual samples prior to subsequent alternate deposition of Zn and Se by MEE at 200 °C to obtain a nominal thickness (See, for example, Figure 3, Column 4, lines 32-34 and 36-38 and Table on Column 6).

However, there is ***no*** disclosure or suggestion in Gaines, *et al.* of growing an initial layer of a film on a substrate at T_{growth}, ***and annealing the initial layer*** of the film at a temperature T_{anneal}, ***thereby substantially completely relaxing the initial layer***, as claimed in Claim 1. In particular, there is no disclosure or suggestion in Gaines, *et al.* of a method that includes the step of annealing the initial layer of Zn or Se, thereby substantially completely relaxing the initial layer. "$\mathbf{T}_{initial}$" of the Table on Column 6 of Gaines, *et al.* indicates the growth temperature of initial fractional monolayer 94 of either Zn or Se ***for separate individual samples a through h*** prior to subsequent alternate depositions of layer 96 of Zn and Se by MEE at 200 °C (See, for example, Column 4, lines 32-34 and 36-38 and Table on Column 6).

Moreover, the approach of Gaines, *et al.* to obtain epitaxial layers having low defects is different from that of Applicant's invention, as discussed below.

Applicant's invention employs the step of growing an initial layer of a film and the separate step of ***annealing the initial layer to allow relaxation*** of the crystal structure of the material of the initial layer. As a result, any dislocation can nucleate during initial stages of growth of the film and any strain beyond perfect domain matching is relieved by a systematic variation in domain size. By allowing relaxation of the crystal structure of the material of the initial layer, most of the defects (dislocations) are near the interface with the substrate, leaving fewer lattice strains and attending defects in subsequent layers of the film, to be formed on the initial layer, e.g., near an active region of a device. That is, Applicant's method can provide ***epitaxy in large misfit systems by matching of integral multiples of lattice planes, where lattice misfit can be, for example, as large as 22%*** (see Example 1 on pages 15 through 16).

In contrast, the method of Gaines, *et al.* deals with charge compensation and high mobility of incident species, Zn and Se, ***on a lattice-matching GaAs substrate, where the lattice***

misfit between the film of ZnSe and GaAs is small, and the ZnSe film grows almost pseudomorphically. The ZnSe film grown by the method of Gaines, *et al.* has a lattice constant of 5.6537 Å, which indicates a lattice misfit of less than 1% between the ZnSe film and a GaAs substrate (see Column 6, lines 3-5 and lines 34-36 and Exhibit A for a lattice constant of GaAs (5.6534 Å)). Further, Gaines, *et al.* suggest that the materials and conditions employed should ***minimize relaxation***. See, for example, Column 5, lines 46-48 and Column 7, lines 35-44 of Gaines, *et al.* Gaines, *et al.* also teach, at Column 6, lines 51-60, that a Se initial layer grown at 500 °C was ***more relaxed*** and resulted in significantly ***more defects*** as compared to a Se initial layer grown at 200 °C:

> If exposure begins at the growth temperature (200 °C), then Se-started films are slightly more relaxed than their Zn-started counterparts. If exposure to Se begins at higher substrate temperatures (500 °C), then significantly more defects are observed in the resulting films···. Misfit dislocation densities are increased and much greater relaxation is observed in these films.

Therefore, one of ordinary skill in the art utilizing the teachings of Gaines, *et al.* would not have been motivated to modify the method of Gaines, *et al.* to include an additional step of ***annealing the initial layer***, thereby substantially completely ***relaxing the initial layer***. In fact, Gaines, *et al.* teach one of ordinary skill in the art away from including an additional step of annealing the initial layer, thereby relaxing the initial layer.

Accordingly, Applicant's invention of Claim 1 is novel in view of Gaines, *et al.* Claims 2-15 depend from independent Claim 1. Thus, the subject matter of Claims 2-15 is also novel in view of Gaines, *et al.* The other references cited in the Office Action as pertinent to the subject application, U.S. Patent Nos. 5,637,530 to Gaines *et al.* and 5,442,205 to Brasen *et al.*, are no more relevant than U.S. Patent No. 6,001,669 to Gaines, *et al.* Thus, the subject matter of Claims 1-15 is novel in view of the cited references. Reconsideration and withdrawal of this rejection are respectfully requested.

CONCLUSION

In view of the above remarks, it is believed that all claims are in condition for allowance, and it is respectfully requested that the application be passed to issue. If the Examiner feels that a telephone conference would expedite prosecution of this case, the Examiner is invited to call the undersigned.

Respectfully submitted,

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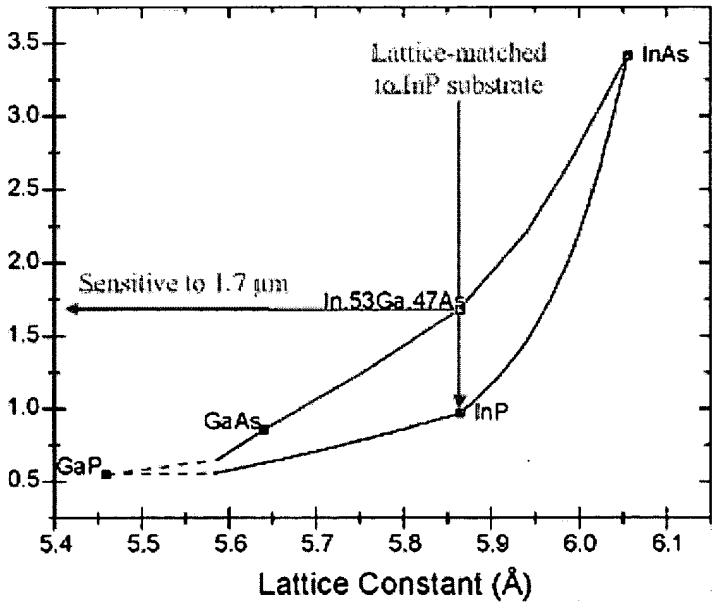
About InGaAs: What is InGaAs?

InGaAs, or indium gallium arsenide, is an alloy of gallium arsenide and indium arsenide more general sense, it belongs to the InGaAsP quaternary system that consists of alloy indium arsenide (InAs), gallium arsenide (GaAs), indium phosphide (InP), and gallium p (GaP). As gallium and indium belong to Group III of the Periodic Table, and arsenic an phosphorous belong to Group V, these binary materials and their alloys are all III-V cor semiconductors.

Why go to all the trouble?

To a large extent, the electrical and optical properties of a semiconductor depend on its bandgap and whether the bandgap is "direct" or "indirect." The energy bandgaps of the members of the InGaAsP quaternary system range from 0.33 eV (InAs) to 2.25 eV (Ga InP (1.29 eV) and GaAs (1.43 eV) falling in between. At Sensors Unlimited we emphas photodetectors, so we care most about the optical properties of semiconductors. A semiconductor will only detect light with photon energy larger than the bandgap, or put way, with a wavelength shorter than the cutoff wavelength associated with the bandgap "long wavelength cutoff" works out to 3.75 µm for InAs and 0.55 µm for GaP with InP a and GaAs at 0.87 µm.

By mixing 2 or more of the binary compounds, the properties of the resulting ternary ar quaternary semiconductors can be tuned to intermediate values. The challenge is that does the energy bandgap depend on the alloy composition, so also does the resulting l constant. For our four friends, the lattice constants range from 5.4505 Å (GaP) to 6.058 with GaAs at 5.6534 Å and InP at 5.8688 Å. Relationship between the lattice constant a long wavelength cutoff of the 4 ternary alloys in the InGaAsP family are shown in Figur



Let's get back to InGaAs...

The InAs/GaAs alloy is referred to as $In_xGa_{1-x}As$ where x is the proportion of InAs and proportion of GaAs. The lattice constants and long wavelength cutoffs of these alloys a depicted as the red lines in Figure 1. The challenge is that while it's possible to make th In Ga As by a number of techniques, a substrate is required to hold up the thin film

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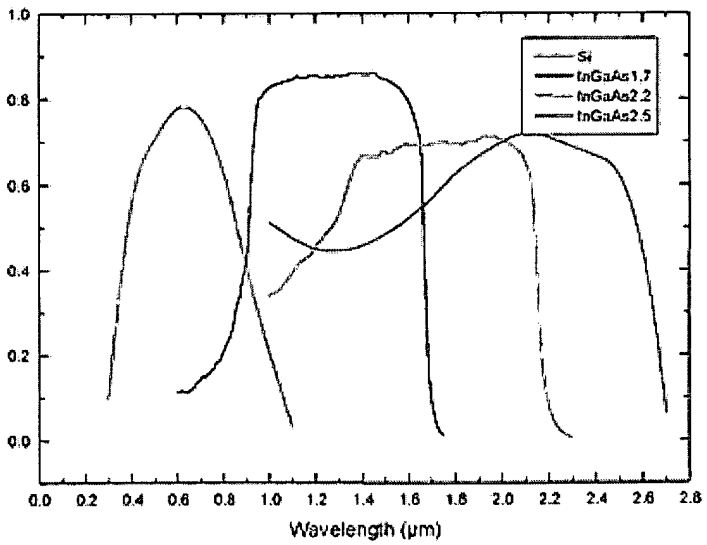
In_xGa_{1-x} is by a number of techniques, a substrate is required to hold up the thin film. If the film and the substrate do not have the same lattice constant, then the properties of the will be severely degraded.

For lots of reasons (call us to chat if you'd like to learn more), the most convenient sub: $In_xGa_{1-x}As$ is InP. High quality InP substrates are available with diameters as large as $In_xGa_{1-x}As$ with 53% InAs is often called "standard InGaAs" without bothering to note t of "$_x$" or "$_{1-x}$" because it has the same lattice constant as InP and therefore the combin: to very high quality thin films.

Standard InGaAs has a long wavelength cutoff of 1.68 µm. Mother nature smiled on thi because it is sensitive to the wavelengths of light that suffer the least signal dispersion transmit furthest down a glass fiber (1.3 µm and 1.55 µm), it detects "eye-safe" lasers (wavelengths longer than 1.4 µm), and it is the optimum wavelength band for detecting natural glow of the night sky. Our core product lines are based on PIN and avalanche photodiodes and photodiode arrays made from standard InGaAs. Take the time to brov through the rest of our site to learn about our many offerings including area and line sc cameras, one and two dimensional focal plane arrays, and high-speed photodiodes an receivers.

So what is "extended wavelength" InGaAs and why bother?
Standard InGaAs has a long wavelength cutoff of 1.68 µm. Many applications require t detection of light with longer wavelengths. An important example is the ability to measu moisture content in agricultural products by measuring water absorption at 1.9 µm. Anc example is "LIDAR" (light detection and ranging), used in airplanes to detect clear air t LIDAR systems often use lasers that emit light with a wavelength of 2.05 µm. In_xGa_{1-x} longer cutoff is called "extended wavelength InGaAs."



All we have to do is add a little more InAs to the mix, right? It's not so easy. This increa lattice constant of the thin film, which causes a mismatch with the substrate, and this re quality of the thin film. We've put a lot of work into learning to grow high quality extende wavelength InGaAs (again, call to chat), and this is reflected in our product offerings. T of our efforts are summarized in Figure 2. Figure 2 shows the quantum efficiency of sta InGaAs in blue together with the quantum efficiencies of two extended wavelength allo (green) and X=0.82 (red). The spectral response of silicon is also shown. As we like to "$In_xGa_{1-x}As$ starts where silicon leaves off."